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Fire Prevention Measures for Cutting, Welding, and Related Activities

Preamble

This Bulletin contains the requirements, standards and guidelines governing fire safety for "hot work" activities at Department of Energy (DOE) facilities. It is being issued to address the need for a comprehensive restatement of applicable criteria and the dissemination of lessons learned arising from a series of related accidents across the complex. The Bulletin should be utilized in the development, implementation, and maintenance of a comprehensive fire safety program for cutting, welding, and related activities.

Introduction

Recently, a number of fires and related incidents involving cutting or welding activities and other sources of open flame and heat have been reported at DOE facilities. These culminated in a fatality at the K-25 Site in Oak Ridge, Tennessee, on February 13, 1997. In that incident, molten metal from a cutting operation ignited a welder's anti-contamination clothing. Since the welder was working alone with his senses inhibited by multiple layers of protective clothing, welder's goggles and a respirator, the flames spread undetected until they were beyond his ability to extinguish without assistance.

The purpose of this Bulletin is to summarize existing DOE and industry requirements, standards, and guidelines that are applicable to hot work and related activities that represent a significant fire risk to DOE and contractor personnel, programs, and facilities. In addition, the lessons learned from the above-referenced incident and others are reflected herein. The objective is to facilitate the implementation of comprehensive and effective site policies, programs, procedures, and training related to fire safety in environments characterized by the use of oxy-fuel gas and electric arc cutting and welding equipment and related activities.

Background

DOE fire protection program requirements and supplemental guidance relating to safety during cutting and welding operations and related activities are contained in a number of source documents, including the following:

- Code of Federal Regulations (29 CFR 1910.252, et al.)
- DOE Order 420.1, "Facility Safety"
- DOE Order 440.1, "Worker Protection Management for DOE Federal and Contractor Employees"
- National Fire Protection Association (NFPA) Standard 1, "Fire Prevention Code"
- NFPA Standard 51B, "Fire Prevention in Use of Cutting and Welding Processes"
- American National Standards Institute (ANSI) Standard Z49.1, "Safety in Welding, Cutting and Allied Processes"
- Implementation Guide to DOE Orders 420.1 and 440.1, "Fire Safety Program"
- DOE Fire Protection Handbook, (DOE-HDBK-1062-96)
- DOE site-specific requirements and guidelines

Considered together, these documents contain the following requirements:

(1) A "management commitment" to implement a fire protection program that is "consistent with the best class of protected property in private industry."

(2) The performance of a job safety analysis (JSA) by a qualified safety professional. For cutting and welding operations involving decontamination and decommissioning (D&D), the JSAs are to include "the fire risks associated with materials and processes used as part of the D&D process." The dismantling of process lines is "to be preceded by an analysis or performed under a work plan which addresses the methods used to control related hazards."

(3) The use of "a permit" (or equivalent) for cutting and welding operations outside of designated welding shop areas, which includes "the analysis of hazards, appropriate precautions and authorizing signature(s)."

(4) The provision of "appropriate protective clothing" commensurate with the hazards.

(5) The posting of a fire watcher "in all exposed areas." The fire watcher must be "appropriately trained" to ". . . watch for fires, use portable fire extinguishers, and notify emergency response forces."

(6) The provision of manual fire fighting equipment. (Automatic fire suppression systems are required "throughout all significant facilities and in all areas subject to . . . significant life safety hazards . . . or fire loss potential in excess of defined limits.")

(7) "Access to a fully staffed, adequately trained and equipped emergency response force that is capable of timely and effective response to site emergencies." DOE also requires "physical access and appropriate equipment to facilitate effective intervention by the fire department."

(8) The development and implementation of "site-specific policies, programs, and procedures governing unique activities (including hot work) that may be outside the scope of the DOE fire protection program requirements."

Management Commitment

An essential element of an effective fire safety program for hot work activities is a firm management commitment to loss prevention. DOE Order 420.1 requires a written policy statement that must ". . . affirm management's commitment to support a level of fire protection and fire suppression capability sufficient to minimize losses from fire and related hazards consistent with the best class of protected property in private industry."

Management should be responsible for the following:

- reviewing operations with their fire safety staff on a regular and frequent basis
- implementing written loss prevention policies
- providing resources to assure adequate training
- promoting employee awareness of fire safety

Subcontractors

Factory Mutual Research Corporation has determined that approximately one-third of cutting and welding losses are caused by contractors and subcontractors, often during construction and demolition activities. Some may not be sufficiently trained in the risks from fire at DOE facilities. When relying on subcontractors, management is responsible for the following:

- requiring subcontractors to comply with DOE and industry fire safety criteria
- requiring subcontractors to attend regular safety meetings
- ensuring that subcontractor workers are properly trained and equipped
- advising subcontractors of the presence of fire hazards characteristic of the site

Job Safety Analysis

A JSA, along with the permit process, are tools to comprehensively and qualitatively assess the personnel and facility risks associated with cutting and welding operations. The JSA should review each step of the task to identify potential hazards and to establish mitigating features to enable the task to be performed safely. It should include an assessment of fire hazards such as direct flame impingement, radiant heat, hot gases, smoke migration, and other related risks in relation to potentially vulnerable workers and other occupants, contents, and the structure. The JSA should be conducted by a qualified safety professional(s) (e.g., fire protection engineer, industrial hygienist, health physicist, etc.), as needed. When multiple disciplines are involved, the analysis should be done in concert. The JSA should be performed on a "graded basis." This means that the level of effort and documentation required for uncomplicated activities is significantly less than that required for recognizably more hazardous tasks.

Permits

The decision to proceed with cutting or welding should be made by the supervisor of the task/operation. If there are questions concerning the hazards or the proper safety precautions needed, the supervisor should consult the cognizant safety professional(s), including a fire protection engineer. NFPA Standards 1 and 51B and the DOE Fire Protection Handbook direct that the authorization to proceed be in the form of a "written permit" when welding is performed outside of designated welding shop areas. (A sample permit is provided in the referenced NFPA Standards. A cutting and welding procedure is provided in the Handbook.)

Work permits should be clearly written and should specify precautions to be taken, such as removal/ protection of combustibles, use of flame-resistant personnel protective equipment (PPE), posting of fire watchers, manual fire fighting equipment, and notification instructions for emergency services.

Prior to approving the permit the supervisor should:

- inspect the proposed work area
- verify the completion of the JSA
- determine necessary precautions
- verify that the permit is clearly written and has been discussed with the workers such that they fully understand what precautions are required

Isolation/Protection of Combustibles

During cutting/welding and related activities, isolation or protection of combustibles in the surrounding work area is of primary importance. Cutting operations, for example, frequently produce globules of molten metal or hot slag that can ignite proximate combustible materials. In the February 13, 1997 fatality, it was molten metal that ignited the welder's PPE. 29 CFR 1910.252 states that "cutting or welding shall be permitted only in areas that are or have been made fire safe."

The following guidance for the removal and/or protection of combustibles during welding/cutting and related activities is taken principally from the NFPA "Industrial Fire Hazards Handbook."

- Welding and cutting must not be permitted (1) in flammable (explosive) atmospheres; (2) near large quantities of exposed, readily ignitable materials; (3) in areas not authorized by management; or (4) on metal partitions, walls, or roofs with combustible covering or with combustible construction.

- Floors should be free of combustibles, such as wood shavings. If the floor is of combustible material, it should be kept wet or otherwise protected.

- If the combustibles are closer than 35 feet to the welding or cutting process, and the work cannot be moved or the combustibles relocated, they should be protected by non-asbestos, flame-resistant materials. (Note that Paragraph 4.3 of ANSI Standard Z 49.1 requires that clothing worn by workers be selected to minimize the potential for ignition, burning, and trapping of hot sparks. It also provides additional criteria for flame-resistant protective clothing.)

- Openings in walls, floors, and ducts within 35 feet of the work should be covered.

- Cutting or welding of pipes or other metal in contact with combustible walls, partitions, ceilings, or roofs should be prohibited when close enough to cause ignition by heat conduction. (Note that cutting or welding of process lines should not be performed until rendered safe from lingering quantities of volatile materials.)

Personnel Protective Equipment

Both 29 CFR 1910.252 and ANSI Z49.1 contain requirements for the provision of PPE for workers involved in cutting and welding operations. These include criteria for (1) eye and face protection, (2) protective clothing, (3) gloves, (4) aprons, and (5) leggings. In light of the recent fatality, the CFR requirements are considered insufficiently precise with regard to the need for flame resistant clothing. Consequently, DOE has placed additional emphasis on conformance with Section 4.3 of ANSI Z49.1 to achieve acceptable levels of fire safety for cutters and welders.

The selection of appropriate PPE should be based on the results of the JSA. The person performing the hot work should be provided with flame resistant clothing (outer wear). Cotton or synthetic fabrics used in the manufacture of this clothing should meet or be treated to comply with the flame-resistance performance criteria for the test methods delineated in one of the following:

- General Services Administration Federal Test Method Standard 191 (1971), "Flame Resistance of Cloth: Vertical Method 5903.1" (or current equivalent)

- ASTM F1506-94, "Standard Performance Specification for Textile Materials"

- ASTM D3659, "Standard Test Method for Flammability of Apparel Fabrics by Semi-Restraint Method R(1993)"

(Alternate acceptance criteria for the purchase and use of flame resistant apparel may be deemed acceptable when justified by the cognizant fire protection engineer.)

Dedicated Fire Watcher(s)

A fire watch, consisting of one or more appropriately trained and equipped individual(s), should be provided based on the conclusions of the JSA. While it is expected that most cutting and welding operations will require a fire watch, DOE acknowledges that there may be circumstances when one may not be necessary. Such circumstances should be reviewed and approved by a fire protection engineer.

The fire watcher should be an individual who is not involved in other work activity in the area whose responsibilities should also include personnel protection. Fire watchers should be trained in the basic hazards related to hot work, including the generation and nature of hot slag and molten metal. Additional training should include the care and use of manual fire fighting equipment, the location of fire alarms or other means to summon emergency response forces, the "stop, drop, and roll" technique of fire extinguishment, and any unusual risks associated with the particular activity at hand.

Where required, fire watchers should remain in place at least 30 minutes after completion of welding and cutting operations, as stipulated by NFPA 51B and the JSA. Prior to the welder(s) leaving the area, his apparel should be inspected by the fire watcher for the presence of hot slag and smoldering fabric.

Manual Fire Fighting Equipment

A portable fire extinguisher of a type and size appropriate for the hazard (including personnel hazards) should be provided for each fire watcher and be readily accessible. The extinguisher should be in good working order, as required by NFPA Standard 10.

Where unusual conditions exist that would adversely affect the efficacy of a portable extinguisher (such as in areas with high ventilation rates), a charged hose line should be provided as an acceptable substitute.

Emergency Services

Emergency services organizations that are expected to respond to potential fires and casualties resulting from cutting/welding and related activities should be familiar with areas in which these activities are planned. This can be accomplished by routine facility tours and/or the periodic review of current fire pre-plans.

To the extent that these areas represent an unusual challenge to effective response, such as in confined space locations, appropriate additional precautions

should be taken. Such precautions may include the pre-positioning of fire fighting and emergency medical equipment.

Where local emergency medical service (EMS) is provided separate from the fire department, the site safety and health organization should work with the EMS provider to assure that an effective response capability exists in the event it is needed.

Fire watchers should be informed of the location of the fire alarm pull station and telephone nearest to the cutting/welding activity. Where there is no fixed means to summon emergency services to the area, the fire watcher should be provided with a working radio or a cellular phone and instructed in its proper care and use.

Site Specific Hot Work Policies and Procedures

To the extent that individual sites may feature atypical cutting/welding and related activity or when a JSA reveals unusual and significant fire risks, DOE expects that the site safety and health organization will address these activities and risks by developing site-specific risk minimization policies and procedures.

Information Sharing

One of the issues that arose in conjunction with the investigation of the February 13th fatality was the lack of awareness of the flammability of lightweight, cotton anti-contamination clothing. This was despite the availability of published research and the occurrence of a number of previous fire incidents at other DOE sites. It is the responsibility of site fire safety professionals and line organizations to share knowledge of fire risks and experiences with actual losses with the rest of the Department. This can be done through the DOE Lessons Learned Program, published notices and bulletins or through the use of electronic information sharing tools, such as the fire protection LISTSERVER, which is available on the DOE Fire Protection Home Page at *http://www.tis.eh.doe.gov/docs/fire/fire.html*

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